Sustainable Development – Bioremediation and Phytoremediation

The Superfund Research Program (SRP) has supported Sustainable Development since its inception, primarily by developing technologies and tools that reduce the amount and toxicity of hazardous substances in the environment. The research activities below focus on the biologically-based methods to clean contaminated sites. The use of microorganisms (bioremediation) or plants (phytoremediation) relies on natural processes to clean contamination. These technologies require less energy input than most other cleanup strategies, significantly reduce remediation costs, and reestablish healthy, stable ecosystems. SRP's efforts thus contribute to sustainable development in two ways: by reducing required energy inputs for hazardous waste cleanup and by restoring contaminated lands to productive human uses.

Lisa Alvarez-Cohen (alvarez@ce.berkeley.edu) | University of California-Berkeley - Grant P42ES004705

Meta-Omics of Microbial Communities Involved in Bioremediation

Trichloroethene (TCE) and 1,4-dioxane (dioxane) are frequent groundwater contaminants at Superfund sites. Dr. Alvarez-Cohen studies both the fundamental and applied aspects of Dehalococcoides, a bacterium capable of bioremediating chloroethenes. This research will lead to optimization strategies that promote more successful bioremediation of TCE and dioxane.

Jon Chorover (chorover@cals.arizona.edu) | University of Arizona - Grant R01ES017079

Nano-scale Mechanisms of Metal(loid) Rhizostabilization in Desert Mine Tailings

Phytostabilization is the revegetation of mine tailings to reduce wind- and water-borne dispersion of contaminants from hazardous waste sites. Plants can accumulate metals to prevent them from entering the food chain. Dr. Chorover is working to identify multi-scale process-links between biological structure and contaminant geochemistry during phytostabilization of mine tailings.

Mark P Elless (elless@edenspace.com) | Edenspace Systems Corporation - Grant R43ES017572

Phytostabilization and Retirement of Mercury from Wet Ecosystems

Edenspace scientists are working to develop an innovative, low-cost method of extracting Hg from wet ecosystems. Using rabbit-foot grass to hyperaccumulate mercury, they will establish the foundation for a low-cost, solar powered method of removing and stabilizing mercury over large areas of soil and large volumes of water.

Joseph Irudayaraj (josephi@purdue.edu) | Purdue University - Grant R01ES017066

Chemical Mapping of Chromate Uptake, Localization, and Reduction in Remediating Bacteria

Dr. Irudayaraj is developing a novel nanoparticle sensor to better understand the mechanism by which the bacteria Shewanella oneidensis (S. oneidensis) MR-1 is able to reduce Cr(VI) to the less toxic Cr(III). This research provides insights into the characteristics of active bacteria contributing to the reduction so that effective remediation measures can be identified and implemented.

Raina Maier (rmaier@ag.arizona.edu) | University of Arizona - Grant P42ES004940

Phytostablization of Mine Tailings in the Southwestern United States

Mine tailings disposal sites are prevalent in the US Southwest and generally remain unvegetated, enabling harmful metals and air pollutants to spread via wind dispersion and water erosion. Dr. Maier employs phytostabilization, to determine how plant-microbe-metal interactions affect the short- and long-term requirements for, and mechanisms of, revegetation of arid mine tailings.

Gemma Reguera (reguera@msu.edu) | Michigan State University - Grant R01ES017052

Novel Mechanism of Uranium Reduction via Microbial Nanowires

Geobacter bacteria are known to immobilize uranium. The Reguera team investigates Geobacter's nanowires (hair-like appendages which are the primary catalysts for uranium reduction). They have genetically engineered a Geobacter strain with enhanced nanowire production that may simultaneously immobilize uranium while acting as microbial fuel cells to generate electricity.

Jerald Schnoor (jerald-schnoor@uiowa.edu) | University of Iowa - Grant P42ES013661

Phytoremediation to Degrade Airborne PCB Congeners from Soil and Groundwater Sources

Dr. Schnoor's research focuses on the remediation of sites containing airborne Polychlorinated Biphenyl (PCB) congeners. He published the first report of metabolism of PCB congeners inside whole plants. Dr. Schnoor's work is providing information about the key role played by higher plants in the environmental fate of PCBs and how they can be used in land management strategies (phytoremediation) for the rehabilitation of contaminated waste sites

Julian Schroeder (julian@biomail.ucsd.edu) | University of California-San Diego - Grant P42ES010337

Molecular Mechanisms of Heavy Metal Detoxification/Accumulation in Plants

Dr. Schroeder studies plant and metal(loid) interactions, focusing on key transporters for metals in the plant (cellular vacuolar phytochelatin transporters). Modulation of these transporters may allow researchers to engineer plants suited either for phytoremediation or reduced accumulation of arsenic in edible plant materials, such as grains and fruits.

Kate Scow (kmscow@ucdavis.edu) | University of California-Davis - Grant P42ES004699

Transport, Transformation, and Remediation of Contaminants in the Environment

Methyl tert-butyl ether (MTBE), used in gasoline in the United Stated since 1979, is the second most common contaminant in ground waters and public water systems. Dr. Scow's team has cultured a novel, robust, naturally occurring strain of bacteria capable of aerobic mineralization of MTBE, its degradation byproduct tertiary butyl alcohol (TBA) and other gasoline components.

Stuart Strand (sstrand@u.washington.edu) | University of Washington - Grant P42ES004696

Phytoremediation of Pollutants Using Transgenic Plants

Phytoremediation, the degradation of toxic compounds by plants, promises to provide an inexpensive and unintrusive method for reducing human exposure to toxic volatile organic compounds (VOCs). Dr. Strand is working to enhance phytoremediation of trichloroethylene (TCE) by expressing mammalian cytochrome P450 2E1 (CYP2E1) in plants. The research team has achieved orders of magnitude greater oxidation of TCE in transgenic poplar trees.

Bradley Tebo (btebo@ucsd.edu) | University of California-San Diego - Grant P42ES010337

Molecular Mechanisms of Bacterial Metal Redox Transformations

Dr. Tebo's research addresses microbial processes that show promise for the bioremediation of heavy metal contamination; specifically the researchers study the molecular mechanisms by which bacteria sequester heavy metals, particularly hexavalent chromium. This project aims to identify genes and proteins involved, to develop biomarkers of metal bioavailability, and to manipulate these systems for metal bioremediation.

James Tiedje (tiedjej@msu.edu) | Michigan State University - Grant P42ES004911

Molecular Insight into Polyaromatic Toxicant Degradation by Microbial Communities

Dr. Tiedje investigates genes for two key biodegradative steps in the detoxification of chlorinated polyaromatic compounds from the DNA of previously uncultured microorganisms. His goal is to develop quantitative diagnostic tools to predict the potential, rate, and extent of biodegradation at a contaminated site by integrating information from genomics, physiology, and geochemistry.

For additional information about the Superfund Research Program:

Please visit the SRP Website (http://www.niehs.nih.gov/research/supported/srp/)

or contact us (srpinfo@niehs.nih.gov).